

REMARKS

As seen in the Amendment, Applicants have amended **method claim 3** to change the intrinsic viscosity $[\eta]$ of the crude trimethylene terephthalate resin (from 0.2 to 4) to 0.4 to 1.5 dl/g.

Applicants have amended **method claim 9** to change the intrinsic viscosity $[\eta]$ of the crude trimethylene terephthalate resin (from 0.2 to 2) to 0.4 to 1.5 dl/g.

Applicants have amended **method claim 10** to change the intrinsic viscosity $[\eta]$ of the crude trimethylene terephthalate resin (from 0.6 to 4) to 0.4 to 1.5 dl/g.

Support for the intrinsic viscosity $[\eta]$ of the crude trimethylene terephthalate resin (prepolymer) of 0.4 to 1.5 dl/g is found at page 77, line 3 of the application specification.

As also seen in the Amendment, Applicants have amended **method claims 3, 9 and 10** to insert therein the following statement:

said crude trimethylene terephthalate resin is produced by a polycondensation reaction performed in the presence of a catalyst selected from the group consisting of:

a catalyst comprising at least one titanium compound and at least one phosphorus compound selected from the

group consisting of phosphoric acid, phosphorous acid, a phosphorous ester and a phosphorus compound represented by the formula (4),

wherein said at least one titanium compound and said at least one phosphorus compound are used in respective amounts such that the phosphorus/titanium atomic ratio is in the range of from 0.01 to 10, and a catalyst comprising at least one tin compound selected from the group consisting of metallic tin, tin oxide, tin sulfide, tin halide, tin carboxylate and tin alkoxide.

The inserted feature that the catalyst comprises at least one titanium compound and at least one phosphorus compound.... is found in **claim 7** (now cancelled). **Support** for the inserted feature that the catalyst comprises at least one tin compound.... is found at page 131, line 21 to page 132, line 6 of the application specification.

In view of the above-mentioned amendments to claims 3, 9 and 10, claims 5, 6, 7, 8, 12 and 13 have been cancelled.

Claim 3 has also been amended to state that the removal of said cyclic dimer is performed by at least one method se-

lected from the group consisting of a method using a guide-wetting fall polymerizer and a method using a thin film evaporator. The guide-wetting fall polymerizer and thin film evaporator are as, respectively, mentioned in claims 9 and 10.

Applicants have also added the following **new claims 15 and 16:**

15. (New) The method according to any one of claims 3, 9 and 10, wherein said phosphorus compound represented by the formula (4) is at least one compound selected from the group consisting of phenylphosphonic acid and 2,5-dicarboxyphenylphosphonic acid.

16. (New) The method according to any one of claims 3, 9 and 10, wherein said tin carboxylate is at least one compound selected from the group consisting of tin butyrate and tin 2-ethylhexanoate.

Support for new claim 15 is found at page 124, lines 12 and 22 of the application specification. **Support for new claim 16** is found at page 132, line 1 of the application specification.

Applicants believe that instantly amended method claims

3, 9 and 10 cannot be made by any combination of the cited references (Kato et al., Scardino et al., Komiya et al., and Yoshikawa et al.).

With respect to **Komiya et al.** (disclosing the guide-wetting fall polymerization technique) and **Yoshikawa et al.** (disclosing the thin film evaporator), it should be noted that it is never obvious to combine the disclosures of Komiya et al. and Yoshikawa et al. with Kato et al. so as to necessarily arrive at the method of the application invention. This is quite apparent from the following.

As described in the present specification, for solving the problems accompanying the solid-phase polymerization process, there have been proposed various improved melt polymerization processes for producing a PTT having a high polymerization degree, wherein the improved melt polymerization processes include those which are substantially the same as the techniques of Komiya et al. and Yoshikawa et al. However, none of such conventional techniques have solved the problems accompanying the solid-phase polymerization process (see page 12, line 9 to page 17, last line of the application specification). For easy reference, the above-mentioned description of the application specification is quoted below.

"For solving the above-mentioned problems accompanying the solid-phase polymerization process, there have been proposed an improved melt polymerization process for producing a PTT having a high polymerization degree, wherein a disc ring or cage type reactor (WO00/64962) or a disc and donut conductor (U.S. Patent No. 5,599,900) is used for efficiently removing TMG from the polymerization reaction system. However, each of the above-mentioned apparatuses is a vertical agitation-type polymerizer which is equipped with a rotary driving part. Therefore, in the above-mentioned process, when a polymerization is performed under high vacuum for obtaining a polymer having a high polymerization degree, it is impossible to seal the driving part completely. Thus, it is impossible to prevent the entrance of a trace amount of oxygen into the polymer and, hence, a discoloration of the polymer inevitably occurs. Especially, in the case of a PTT, such discoloration markedly occurs. When the driving part is sealed with a sealing liquid, it is likely that the sealing liquid gets mixed with the polymer, thereby lowering the quality of the resultant PTT. Further, even when the driving part of the apparatus is tightly sealed at the start of the operation thereof, the tightness of the sealing is lowered during the operation conducted for a long period of time. Thus, the above-mentioned process also has a serious problem with respect to the maintenance of the apparatuses.

On the other hand, a method for producing a resin (other than a PTT) is known in which the polymerization apparatus used therein does not have a rotary driving part, and a polymerization is

performed by allowing a prepolymer to fall from a perforated plate (free-fall polymerization method). For example, a method is disclosed in which a polyester prepolymer is allowed to fall in the form of fibers in vacuo in an attempt to obtain a polyester having a desired molecular weight (U.S. Patent No. 3,110,547). In this method, a polymerization reaction is performed in a one pass mode without recycling the polymer, because the recycling of a polymer which has already been allowed to fall in the form of fibers causes the lowering of the quality of the final polyester. However, the above-mentioned method has the following disadvantages. The polymer in the form of fibers is easily broken during the polymerization reaction, thereby causing a disadvantageously large fluctuation in quality of the final condensation polymer products. In addition, a low molecular weight condensation polymer is scattered from the polymer fibers during the polymerization reaction to stain the lower surface of the perforated plate. Due to such staining of the lower surface of the perforated plate, it becomes difficult to cause the polymer to fall in the form of fibers, so that the polymer fibers contact with one another to cause breakage of the polymer fibers or the polymer fibers are combined together to form a thick fiber in which the reaction does not proceed efficiently.

In order to solve these problems, various methods have been proposed. Examples of such methods include a method in which a polyester or a polyamide is produced by allowing a prepolymer to fall along and in contact with the surface of a perforated guide or a wire guide, which is verti-

cally arranged in a reaction vessel, so that the polymerization of the prepolymer is effected during the fall thereof (Examined Japanese Patent Application Publication No. Sho 48-8355 and Unexamined Japanese Patent Application Laid-Open Specification No. Sho 53-17569); a method for continuously condensation-polymerizing bis-(β -hydroxyethyl) terephthalate (which is an initial-stage condensation product of polyethylene terephthalate (PET)), in which bis-(β -hydroxyethyl) terephthalate is allowed to fall along and in contact with wire guides in an atmosphere of inert gas, wherein the wire guides are hung vertically from the holes of a perforated plate, so that the polymerization of bis-(β -hydroxyethyl) terephthalate is effected during the fall thereof (Examined Japanese Patent Application Publication No. Hei 4-58806); and a method for producing a melt-polycondensation polymer (such as a polyester, a polyamide or a polycarbonate) in the form of a film, in which a melt-polycondensation prepolymer is caused to absorb an inert gas, and then, polymerized under reduced pressure (WO99/65970 which also discloses an apparatus used in the method).

However, each of the above patent documents only describes a method for producing a polyester (such as a PET) or a nylon, and has no proposal or suggestion about the production of a PTT. As a result of the studies of the present inventors, it has been found that, when any of the above-mentioned methods are simply applied to the production of a PTT (that is, when the production of PTT is conducted by any of the above-mentioned

methods, using raw materials and conditions which are conventionally used in the production of a PTT), a foaming of a polymer vigorously occurs, thereby staining the lower surface of the perforated plate or the inner wall of the reaction vessel having the guides provided therein. The PTT is susceptible to heat decomposition, as compared to, for example, the PBT. Therefore, the stain caused by the above-mentioned vigorous foaming of the polymer is easily decomposed. When the resultant decomposition products get mixed with the polymer, disadvantages are caused that the quality of the polymer is lowered, that the desired polymerization degree cannot be obtained, and that the obtained PTT suffers discoloration. Thus, the simple application of the above-mentioned methods to the production of PTT is accompanied by a problem that it is difficult to achieve a satisfactorily high polymerization degree. In addition, the final PTT contains low molecular weight polymers, which result in a broad molecular weight distribution of the final polymer and are likely to lower the mechanical strength of an ultimate shaped article.

In recent years, there has been proposed a technique in which a PTT prepolymer having a specific polymerization degree is caused to flow through the holes of a perforated plate, and then allowed to fall along and in contact with a guide at a specific temperature under reduced pressure to thereby perform a polymerization of the PTT prepolymer during the fall thereof (Japanese Patent Application No. 2002-172735). By this technique, it has, for the first time, become possible to produce a PTT having a high polymerization de-

gree and an excellent color. However, for meeting the recent demand for high quality fibers and shaped articles, it has been desired to further improve the color and mechanical properties of the polymer. Further, a PTT produced by the conventional melt polymerization process had a disadvantageously high cyclic dimer content and, hence, it has been desired to reduce the cyclic dimer content. Furthermore, it has been desired to solve a problem which arises when the continuous production of PTT is conducted by any of the conventional techniques, that is, a problem that the cyclic dimer which volatilizes from the polymer during the polymerization is deposited on the inner wall of the conduit provided in the production system, thereby causing the clogging of the conduits, so that a stable production of PTT becomes difficult."

(emphasis added) (see page 12, line 9 to page 17, line last line of the application specification)

Thus, conventionally, the problems of the prior art have not yet been satisfactorily solved. More specifically, for example, a polytrimethylene terephthalate (PTT) resin having not only a molecular weight distribution (M_w/M_n) as narrow as from 2 to 2.7, but also a cyclic dimer content as small as not greater than 1.5 % by weight has not conventionally been obtained.

As a result of the present inventors' extensive and intensive studies for solving the above-mentioned problems ac-

companying the prior art and for developing a polytrimethylene terephthalate (PTT) resin which can be used as a raw material for stably producing, on a commercial scale, a shaped article having high quality (i.e., shaped article which has excellent strength and color, and which is free from the bleeding of the cyclic dimer to the surface of the shaped article, so that the shaped article is suitable for coating with a coating composition or adhesive agent and exhibits excellent adhesion property), **it has unexpectedly been found** that, when a crude PTT resin (used as a raw material for the PTT resin of a final PTT resin having advantageously low cyclic dimer content) is produced by a specific method (e.g., a method using a specific catalyst), it becomes possible to obtain a crude PTT resin which is **capable of suppressing the formation of the cyclic dimer even when** the crude PTT resin is melted. Further, by **removing the cyclic dimer** from the obtained crude resin in a molten form by operating a guide-wetting fall polymerizer or a thin film evaporator under specific conditions, it becomes possible to obtain a PTT resin having an intrinsic viscosity $[\eta]$ **as high as** from 0.74 to 4 dl/g, a molecular weight distribution (Mw/Mn) **as narrow as** from 2 to 2.7, a cyclic dimer content **as small as** not greater than 1.5 % by weight, and a psychometric lightness L-value of from 70 to 100 and a psychometric chroma b*-value of from -5

to 25. By using such a PTT resin, it becomes possible to produce an excellent shaped article stably on a commercial scale. Specifically, the **shaped article produced** using the polytrimethylene terephthalate resin of the present invention has **high strength and excellent color**. Further, the shaped article is **free from the bleeding of the cyclic dimer** to the surface of the shaped article, so that the shaped article is **suitable for coating** with a coating composition or adhesive agent and exhibits **excellent adhesion property**.

Therefore, it is believed that any of the method claims 3, 9 and 10 has **novelty and non-obviousness** over the cited references.

With regard to the product recited in independent claim 1, the Examiner appears to take the position that because various references were able to achieve one of the recited properties in isolation, the claimed product, having all of the properties, would have been obvious. However, as described above with regard to the method, the Examiner's rationale does not appear to consider the many tradeoffs involved when attempting to achieve good properties. Optimizing a process to achieve great results for one property usually results in a deterioration of other properties. Only the inventors have been able to develop a product that simultane-

ously achieves all of the properties. The fact that prior art discloses ways to optimize a single property in isolation does not render obvious a product having all of the desired properties. It is submitted that the currently imposed rejections involve picking and choosing features in a hindsight manner. Therefore, it is firmly believed that the prior art rejection should be withdrawn.

Applicants would like to discuss the application with the Examiner. The undersigned unsuccessfully attempted to reach the Examiner to schedule an Examiner Interview. The Examiner is requested to contact the undersigned at his earliest convenience to set up a time and date to review the substance of the outstanding rejections.

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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